

**A SPECIES DESCRIPTION AND BIOLOGICAL  
COMPARISON BETWEEN A NEW SPECIES OF  
*TELENOMUS* HALIDAY (HYMENOPTERA: SCELIONIDAE)  
AND *TRICHOGRAMMA PLATNERI* NAGARKATTI  
(HYMENOPTERA: TRICHOGRAMMATIDAE): TWO EGG  
PARASITIDS OF *SABULODES AEGROTATA*  
(GUENEE) (LEPIDOPTERA: GEOMETRIDAE)**

JEFFREY Y. HONDA AND SERGUEY V. TRJAPITZIN

Department of Entomology, University of California,  
Riverside, California 92521

*Abstract.*—*Telenomus hugi* Honda and Trjapitzin, NEW SPECIES, is described and illustrated. This species is a common egg parasitoid of the geometrid moth, *Sabulodes aegrotata* (Gueneé), which feeds on avocado in southern California. The new species belongs to the *T. californicus* group of the genus *Telenomus* but differs from other species of this group based on the structure of male genitalia. A brief study and discussion of the life history traits of *T. hugi* and its potential as a biological control agent in comparison to *Trichogramma platneri* Nagarkatti are included.

*Key Words.*—Insecta, Geometridae, *Sabulodes aegrotata*, Scelionidae, *Telenomus hugi* NEW SPECIES, *Trichogramma platneri*, egg parasitoid

Species of *Telenomus* often play an important role in the natural control of insect populations, however, their use in biological control programs has been inhibited by a lack of systematic and biological study (Bin & Johnson 1982, Orr 1988). The approximately 600 species of recognized *Telenomus* represent only 10–25% of the species thought to be in existence, and biological studies are few in number when compared to *Trichogramma* (Bin & Johnson 1982). Despite the lack of a strong biosystematic base of information, *Telenomus* species possess a number of characteristics that make them effective natural enemies and good biological control candidates. These include: a high searching capacity, high reproductive potential, high dispersal capacity, wide ecological range, host specificity, and host synchronization (Hirose 1986, Orr 1988). Hirose (1986) concluded that *Telenomus* species should be better control agents than *Trichogramma* species in natural regulation of lepidopterous pests partly because they have greater longevity and higher searching abilities, although Bin & Johnson (1982) concluded that both genera may be complementary for certain hosts.

The omnivorous looper, *Sabulodes aegrotata* (Gueneé) is an important pest of avocados in southern California (McKenzie 1935). Augmentative releases of the egg parasitoid *Trichogramma platneri* Nagarkatti have been used to aid in the control of this pest, however, another egg parasitoid in the genus *Telenomus* was commonly found parasitizing *S. aegrotata* eggs in the field during the last two seasons. The latter species is currently maintained in culture at the University of California, Riverside (UCR), and specimens were sent to N. F. Johnson (The Ohio State University, Columbus, Ohio) for identification. He determined that this species was undescribed.

The presence of both *T. platneri* and a new species of *Telenomus* described

below provides a good system to test the hypotheses stated above in the laboratory. Herein, we provide the scientific name and taxonomic description of *Telenomus hugi* Honda & Trjapitzin, describe its general biology, and discuss its potential as a biological control agent when compared with *T. platneri*.

#### MATERIALS AND METHODS

For taxonomic description, we followed the protocol of Johnson (1984). Measurements are given in millimeters, with the mean followed, in parentheses, by the range within the indicated sample. Abbreviations for depositories are: BMNH, The Natural History Museum, London; CNCI, Canadian National Collection of Insects, Ottawa; OSUC, The Ohio State University, Columbus; UCRC, University of California, Riverside; USNM, National Museum of Natural History, Washington, D.C.; ZMAS, Zoological Institute, Russian Academy of Sciences, St. Petersburg. Abbreviations used in the description are: A = Antennomere; DCI = Dorsal Cephalic Index (head width: dorsal head length); FCI = Frontal Cephalic Index (head width: frontal head length); TL = Total Length (dorsal head length + Weber length + metasomal length); T1, T2: Metasomal tergites 1 and 2 [for explanation of terms see Johnson (1984)].

For biological studies, a culture of *T. hugi* was initiated in May, 1993 with wasps reared from *S. aegrotata* eggs collected from avocado trees in Carpinteria, California (approximately 20 adults were collected from a parasitized egg cluster by JYH in late April, 1993). The culture was maintained on *S. aegrotata* eggs obtained from a moth culture reared on an artificial diet developed by Johnson & Federici (1982) at UCR. The *T. hugi* culture was maintained by exposing approximately 100 freshly laid *S. aegrotata* eggs to five or six mated female wasps in an oviposition rearing unit. This unit consisted of a honey streaked, glass shell vial (9.5 × 2.5 cm) covered with filter paper held in place with a polyethylene lid from which the center was removed. Eggs were held with female parasites for 24 hours and then removed and placed in a new rearing unit until emergence.

Parasitoid developmental times were determined by holding individual parasitized eggs in gelatin capsules until emergence at 27° C, 50% RH, and 14L:10D. To determine the effect of honey and host egg availability on longevity, females were subjected to three treatments: (1) no honey or hosts, (2) honey only, and (3) honey and hosts. Male wasps were subjected to only two treatments: (1) no honey, and (2) honey. Wasps were placed individually in rearing units and checked daily for mortality. Honey was replaced as needed. Due to the irregular availability of *S. aegrotata* eggs, female treatments with hosts and honey were given a section of index card with 20 freshly laid *S. aegrotata* eggs 9, 13, 17, 19, 22, 25, and 28 days after emergence. Collected eggs from each treatment ( $n = 12$ ) were held for emergence to estimate sex ratio and fecundity.

#### TAXONOMY

##### *TELENOMUS HUGI* HONDA & S. TRJAPITZIN, NEW SPECIES

*Types*. — Holotype: female (on point), labeled: 1. "*Telenomus hugi* Honda et S. Trjapitzin HOLOTYPE female"; 2. "USA. CALIFORNIA. RIVERSIDE Co.: Riverside, UCR lab. culture, 24 Mar 1994, J. Honda, ex. *Sabulodes aegrotata* (Gueneé)". Holotype deposited in U.S. National Museum of Natural History, Washington D.C. Paratypes, same data as holotype: 1 female, 2 males [USNM];

1 female, 1 male [BMNH]; 1 female, 2 males [CNCI]; 2 females, 2 males [OSUC]; 1 female, 2 males [ZMAS]; 12 females, 23 males [UCRC].

*Female*.—*Color*: General body coloration black; eyes and ocelli gray; A3–A6 slightly lighter than remainder of antenna; fore and mid femora brown distally; tibiae light brown basally and distally; tarsi light brown to brown, darkening distally. *Head* (Fig. 1): Vertex smoothly rounded onto occiput, coriaceous; hyperoccipital carina absent; occiput with very fine coriaceous sculpturing, almost smooth; orbital bands broad and incomplete, with broad interruption medially; frons otherwise smooth, shining; no ocellar setae; preocellar pit usually absent; frontal depression apparently absent; frons slightly elevated between antennal insertions and inner orbits; eyes hairy; malar space coriaceous but smooth at toruli. *Mesosoma*: Mesoscutum coriaceous, evenly covered with small setae; scutellum smooth except some fine sculpturing anteriorly, with sparser arranged setae; dorsellum (Fig. 2A) strongly punctate in anterior one-half, striate to smooth posteriorly. *Metasoma*: T1 (Fig. 2B) with 3 pairs of lateral setae and 1 pair of sublateral setae. *Appendages*: Antenna (Fig. 3) densely setose, 11-segmented; club 5-segmented; scape (A1) about 4 × as long as pedicel (A2); A3 as long as A2 and longest of funicle (A3–A6), A4 as long as broad, A5 slightly smaller than A4, A6–A10 transverse. Wings hyaline, surpassing apex of metasoma; postmarginal vein of forewing longer than stigmal vein; hindwing broad, maximum width about 1.5 × of fringe hairs length at this point. *Measurements* ( $n = 5$ ): TL: 0.86 (0.82–0.87) mm; DCI: 2.60 (2.06–3.27) mm; FCI: 1.27 (1.23–1.31) mm; frons W: eye height: 1.04 (1.02–1.07) mm; W: L T1: 3.93 (3.33–4.60) mm; L: W T2: 0.90 (0.83–1.00) mm; L: W metasoma: 1.41 (1.30–1.54) mm.

*Male*.—Similar to female except antennae and hind legs concolorous with body. Normal secondary sexual characters as follows: antenna (Fig. 4) 12-segmented, densely setose, A1 almost equal to combined lengths of A2–A4, A3 and A5 subequal, A4 as long as A12, A6–A11 moniliform; genitalia (Fig. 5) elongated, aedeago-volsellar shaft just over 3 × as long as basal ring, constricted proximally and slightly bowed medially; basal ring appears knobbed proximally with a round base, constricted medially and distally; laminae volsellares very closely approaching one another medially to appear fused; digiti three-dentate, with long and thick teeth; aedeagal lobe rounded, slightly longer than digiti. *Measurements* ( $n = 5$ ): TL: 0.86 (0.83–0.88) mm; DCI: 2.63 (2.29–3.17) mm; FCI: 1.21 (1.16–1.28) mm; frons W: eye height: 1.04 (0.94–1.13) mm; W: L T1: 3.73 (3.00–4.25) mm; L: W T2: 0.83 (0.76–0.89) mm; L: W metasoma: 1.36 (1.26–1.42) mm.

*Diagnosis*.—The new species belongs to the *californicus* species group of *Telenomus*, as defined by Johnson (1984), and differs from other species in this group based on unique male genitalia structures described above (Fig. 5).

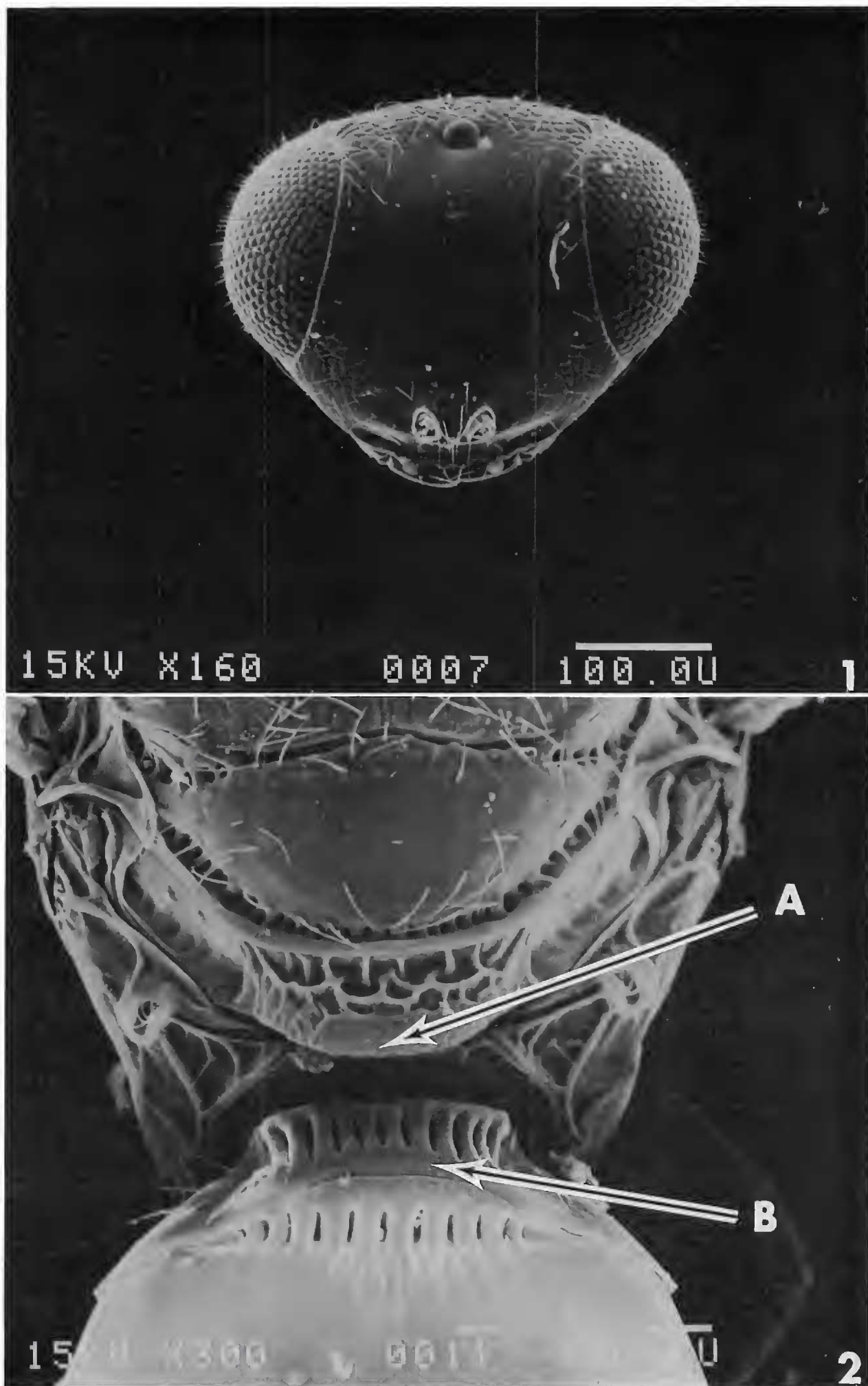
*Etymology*.—The specific name “*hugi*” was chosen to honor P. “Hugi” Bear.

*Material Examined*.—See types. Additional specimens: same data as holotype, 3 females, 3 males, parts mounted for scanning electron microscopy [UCRC].

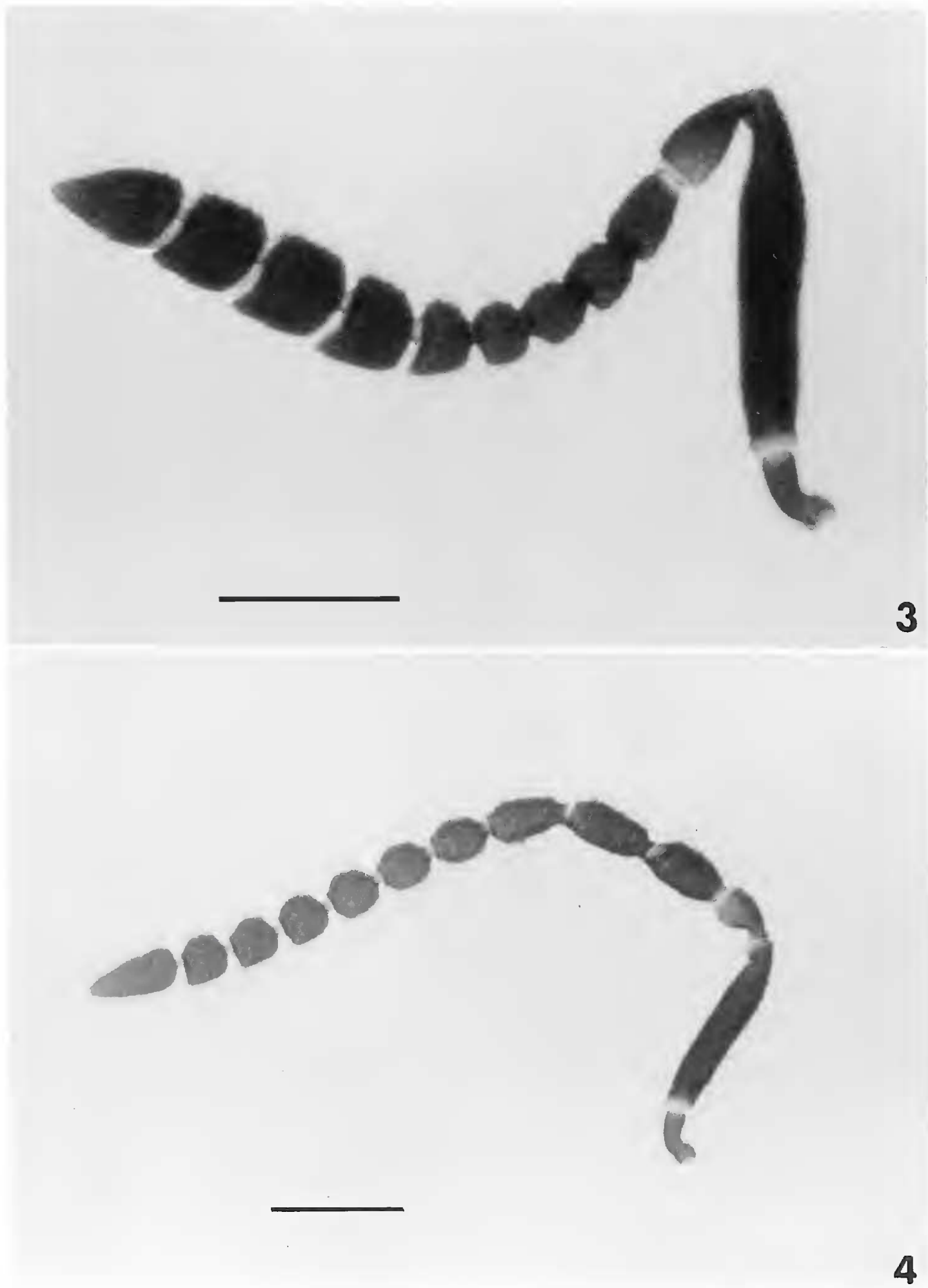
## BIOLOGY

*Results*.—A number of general observations were made regarding the biology of *T. hugi*. This parasitoid may be fairly host specific because it failed to elicit any ovipositional response when presented a number of alternate host eggs, including *Manduca sexta* (Johannson) (Sphingidae), *Amorbia cuneana* Walsingham (Tortricidae), *Trichoplusia ni* (Hübner) and *Spodoptera exigua* (Hübner) (Noctuidae). However, alternative species of geometrid eggs were not available for experimentation. Female wasps presented *S. aegrotata* eggs quickly examined hosts by drumming them with their antennae, followed by drilling with the ovipositor and egg deposition. Total parasitism times averaged  $3.31 \pm 1.34$  min for five individual females without prior oviposition experience. Females isolated from males ( $n = 10$ ) parasitized eggs that issued only male wasps, indicating that this species is arrhenotokous. Both male and female developmental times were similar ( $17.24 \pm 0.43$  ( $n = 106$ ) for females and  $17.10 \pm 0.30$  ( $n = 50$ ) for males).





Figures 1-2. *Telenomus hugi* Honda & Trjapitzin, NEW SPECIES, paratypes [all UCRC]. Figure 1. Head (female, frontal view). Figure 2. Posterior mesosoma and anterior metasoma (female, dorsal view): A—dorsellum, B—T1. Scale bars = 0.1 mm.



Figures 3–4. *Telenomus hugi* Honda & Trjapitzin, NEW SPECIES, paratypes [all UCRC]. Figure 3. Antenna (female). Figure 4. Antenna (male). Scale bars = 0.1 mm.



Figure 5. *Telenomus hugi* Honda & Trjapitzin, NEW SPECIES, paratype [UCRC] Genitalia (male). Scale bar = 0.1 mm.

at 27° C. Wasps deprived of honey did not survive for more than 24 h and died significantly sooner than those supplied honey (Table 1). Wasps supplied honey and hosts survived less than one month, whereas wasps supplied only honey survived well over a month. This difference was significant ( $F_{[2, 37]} = 20.60$ ,  $P < 0.01$ ). Females usually did not begin parasitizing hosts until four or five days after eclosion even when given hosts in the first two or three days of adult life, indicating

Table 1. Longevity (in days  $\pm$  SEM) of male and female *T. hugi* when given no honey, honey, and honey with hosts. Values followed by different letters in each column are significantly different (ANOVA, Duncan's multiple range test,  $P < 0.01$ ).

	Male (n)	Female (n)
No honey	1.00 $\pm$ 0.00a (20)	1.00 $\pm$ 0.00a (13)
Honey	41.25 $\pm$ 1.94b (16)	59.00 $\pm$ 1.43b (15)
Honey and hosts	—	29.42 $\pm$ 3.05c (12)

that parasitoid eggs may take a few days to mature. Parasitized eggs produced single offspring and females appeared to mark a parasitized host immediately after oviposition by scrapping their ovipositor over the host's surface. We did not observe host feeding by *T. hugi*. A female *T. hugi* laid an average of  $52.08 \pm 2.27$  eggs ( $n = 12$ ) when given hosts over a 28 day period (Fig. 6). During the first three days, 80% of the offspring were females, however, by the time the fourth batch of eggs was presented to the females, wasp mortality had increased, and the number of eggs laid per female and their sex ratio had declined. The sex ratio decline was probably due to sperm depletion. By the 28th and 30th day most of the wasps were either dead or moved sluggishly, ignoring the egg clusters we offered them.

*Discussion.*—The association existing between *T. hugi* and *S. aegrotata* probably has been reported previously, however a complete species description and biological study has not been published. For example, McKenzie (1932) and Oatman et al. (1983) noted collections of *Telenomus* emerging from *S. aegrotata* eggs. They did not identify this species, which may have been *T. hugi*.

The importance of *T. hugi* as an integral part of *S. aegrotata*'s natural enemy complex is unknown. Extensive sampling and field studies of this species are lacking. In fact, *Telenomus* taxonomy and biology studies remain relatively scarce and few examples of successful classical biological control using *Telenomus* species exist (Bin & Johnson 1982). However, our results and observations in the laboratory indicate that this parasitoid has many of the characteristics considered desirable in a successful natural enemy.

Many workers have compared the potential of *Trichogramma* and *Telenomus* species as biological control agents and concluded that *Telenomus* species may be more effective (Hirose 1986, Orr 1988). In general, *Trichogramma* species are thought to be too short lived, posses too short a developmental period that inhibits synchronization, and are too polyphagous when compared to *Telenomus* species. In contrast, *Telenomus* species are usually thought to be better searchers because they live longer, are usually solitary parasitoids, and are more host specific. However, *Telenomus* and *Trichogramma* species can be complimentary or interchangeable for certain hosts and niches, and preliminary tests are indispensable in evaluating the role each may play in a biological control system (Bin & Johnson 1982). Preliminary studies on the biology of *T. hugi* along with previous studies on the biology of *T. platneri* (Manweiler 1982; Hohmann et al. 1988; JYH, unpublished data) allow *T. hugi* to be evaluated and compared with *T. platneri*.

The reproductive potential of *Trichogramma* species are generally greater than that of *Telenomus* species (Hirose 1986, Orr 1988) and *T. platneri* follows this pattern when compared with *T. hugi*. The intrinsic rate of increase, ( $r_c$ ) for *T.*



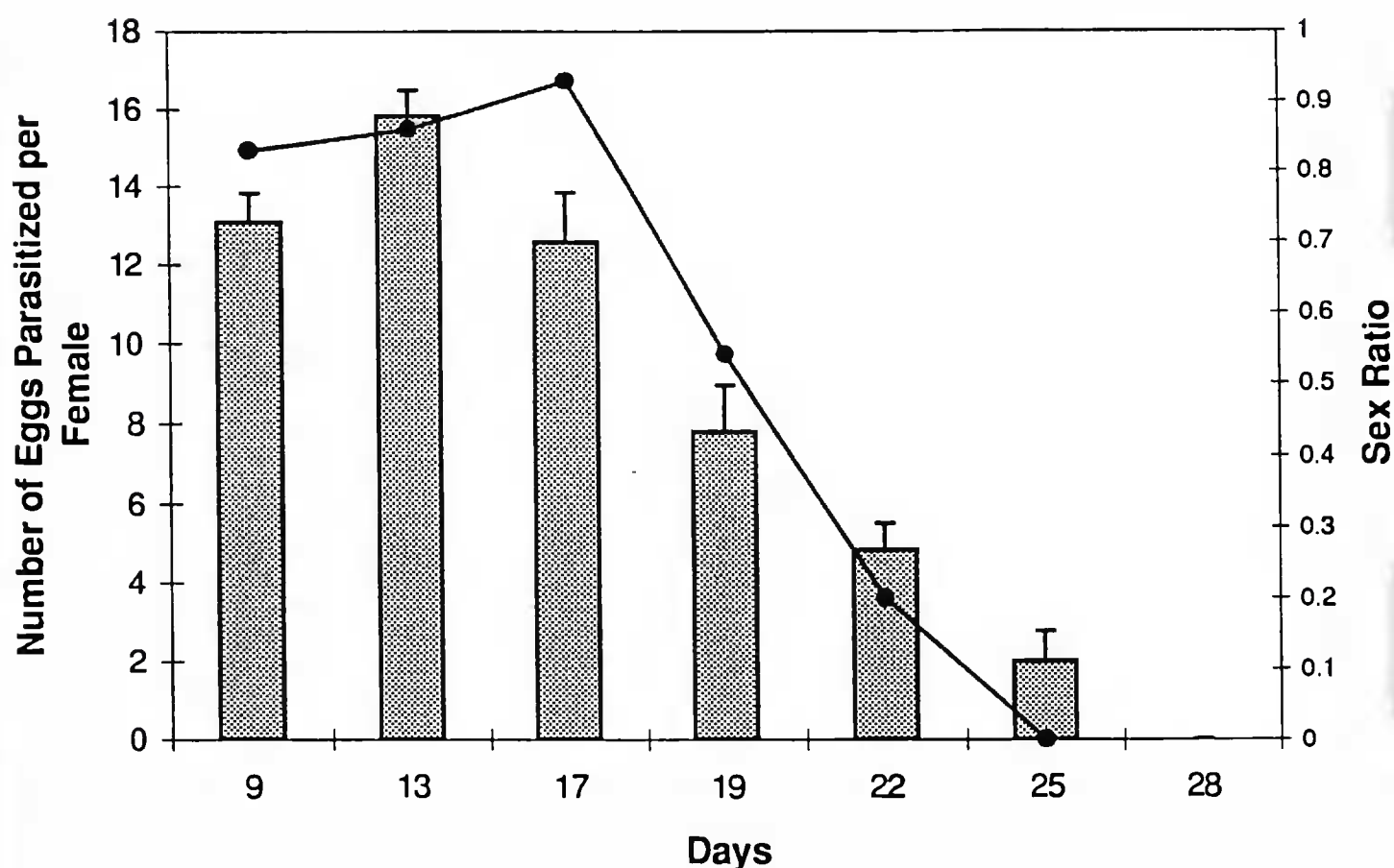


Figure 6. Mean numbers of eggs parasitized per female ( $\pm$  SEM) per given day. Line indicates mean percentage of females emerging.

*platneri* is 0.368 (Orr 1986 taken from Manweiler 1982), which is higher than *T. hugi* (0.219) at 27° C. Furthermore, inexperienced *T. platneri* with mature egg loads produced more progeny during a 24 h period than *T. hugi* ( $26.76 \pm 7.93$  versus  $13.14 \pm 2.47$ ). However, *T. platneri* is gregarious, laying  $5.50 \pm 1.75$  offspring per *S. aegrotata* egg, whereas *T. hugi* is solitary, laying one egg per *S. aegrotata* egg. Thus, a more appropriate measure of the impact of these two wasps species is the number of *S. aegrotata* eggs a female wasp of each species parasitized. When this criterion is used a different picture emerges: *T. platneri* parasitized an average of  $4.87 \pm 1.41$  eggs per female (JYH, unpublished data), whereas *T. hugi* parasitized an average of  $13.14 \pm 2.47$  eggs per female in a 24 h period. Therefore, *T. hugi* may inflict more mortality even though *T. platneri* has a higher fecundity. Furthermore, *T. hugi* may have a more restricted host range, as females did not parasitize four alternative moth species when offered host eggs. *Telenomus* species are generally host specific with a few exceptions, and even polyphagous species appear to be restricted to families within Lepidoptera (Orr 1988). In contrast, *T. platneri* is polyphagous, with members of the species complex parasitizing the eggs of at least 30 different hosts in several lepidopteran families (Pak 1988), including *A. cuneana*, which is also an important pest in avocado grooves and occurs throughout the year (Bailey et al. 1988).

*Trichogramma platneri* is augmentatively released for the suppression of *A. cuneana* and *S. aegrotata* in avocado orchards. Studies (JYH, unpublished data) indicate that *T. platneri* is a more effective biological control agent for *A. cuneana* than *S. aegrotata*. Although *T. platneri* is collected from *S. aegrotata* in the field, laboratory experiments indicate that it has difficulty parasitizing *S. aegrotata* eggs because they have a hard chorion and a sticky secretion that covers the eggs (JYH, unpublished data). Female *T. platneri* take approximately 15 min to penetrate



the chorion. In contrast, *T. hugi* oviposits in an *S. aegrotata* egg in about three minutes. Moreover, large *T. platneri* loose interest in parasitizing more than two or three *S. aegrotata* eggs even though they possess a substantial egg load, whereas they nearly exhaust their mature eggs parasitizing *A. cuneana*.

Finally, *T. platneri* lives at best eight days post emergence (Hohmann et al. 1988), which is significantly shorter than *T. hugi*. Such a short life span may not allow adult *T. platneri* to synchronize with the three or four discrete annual generations of *S. aegrotata* (Bailey et al. 1988). Augmentative releases may improve *T. platneri*'s synchrony, but they must be properly timed to coincide with the presence of *S. aegrotata* eggs in the field (Oatman & Platner 1985). In contrast, *T. hugi* can live well over a month, which may increase its probability of encountering hosts.

These results suggest that *T. hugi* may be a better biological control agent than *T. platneri* for *S. aegrotata*. Although *T. platneri* is collected on *S. aegrotata* in the field, laboratory experiments indicate that *T. platneri* is short-lived and has difficulty in parasitizing *S. aegrotata*. Hence it does not kill sufficient numbers of eggs when given an egg cluster of eggs which average approximately 13 eggs (JYH, unpublished data). The one advantage *T. platneri* has over *T. hugi* is that it is easier to mass produce. No cost effective methods are currently available to rear *T. hugi* in large quantities. Until such a cost effective rearing system is developed for *T. hugi*, augmentative releases of *T. platneri* may still play a complimentary role in the suppression of *S. aegrotata*.

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